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## THE TEACHING OF STATISTICS.\*

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To the mind of the average undergraduate the word "statistics" represents columns of figures and little else. He knows that these figures play a large rôle in the world about him, and is naturally curious to learn something about them. The graduate student may take advanced work along this line, with a very definite end in view. But the number of such is comparatively small in any university. Most of the statistical courses which are offered in American colleges are elementary in nature, and are elected by students who are somewhat ignorant of the exact nature of the work they are choosing. It is to the instructor of such a course that this paper is presented for consideration and criticism.

Without entering upon a discussion of the place of statistics in a classification of the sciences, and without endeavoring to determine whether it is itself a science or a method, no one will deny that it is a most useful tool for scientific study in several branches of knowledge. The aim of the instructor in statistics should ever be to make the student expert in the use of this tool. This task is by no means so easy as might at first appear.

Since a considerable ability in mathematics is necessary, and a decent knowledge of the fundamental concepts of economics and sociology is desirable, it seems advisable that an elementary course in statistics should not be introduced before the Junior year in college, if satisfactory results are to be obtained. The frequency of recitations will depend upon the schedule adopted in different institutions, but the equivalent of two hours per week throughout the college year is none too much to furnish the necessary training. Since, by the nature of the subject, the class-room work must be intensive and personal, twenty-five

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men are all who should receive instruction at the same time. If the course is elected by a large number, several divisions should be formed.

In an elementary course a text-book should be selected to serve as a skeleton for the work, and by regular assignments hold the men to their tasks. But it is well to recognize, at the start, that the ability to memorize a column of figures is not the end in view. At a certain period of development a memory test, like the learning of the multiplication table, may be desirable, but the gain in power which should come from training in statistics is very different. The instructor should bear in mind that he is not trying to turn out trained parrots.

At the outset of the course the attention should be directed to the theory of statistics. The class should follow the development of a typical problem, from the gathering of the raw material to the lessons taught by the consideration of the finished product. This will afford opportunity for a description of the different methods employed in collecting data, with the advantages and disadvantages of each one; the various ways in which the material may be tabulated and arranged; the use of the different kinds of averages, the mode, and the median; the meaning of accuracy and error and the proper correlation of two or more quantities. In this connection some time should be devoted to a study of the theory of probability, together with a statement of the usefulness and dangers of conjecture. While any of these topics is under consideration, it is well to give examples to the class, to be either worked out in the classroom or to be computed before the next recitation. Before anything else is done, the problem should be demonstrated and carefully explained to the class. It is indispensable that the fundamentals of theory should be appreciated by all.

In view of the bewildering mass of statistical information which is being poured upon the world at present, it is hopeless to expect that the student will carry much of this in memory. In fact, except to certain trained statisticians, these figures are a means rather than an end. But since every educated man is interested in the economic and social problems of his country,

and may wish, from time to time, to know what light statistics throws upon them, it is important that he should know where to turn for the most reliable information. He should be shown in what public or private publications he could expect to find the most accurate figures upon these subjects. But the fact should not be concealed that in many cases these are, at best, incomplete. It is undoubtedly discouraging to the student to learn the truth with regard to the condition of the vital statistics of this country, but the determination of truth is the end of knowledge, and a more general recognition of the shortcomings of our information upon these subjects may assist to bring the needed reformation. That the students may familiarize themselves with these source books, it is good policy to assign to them the task of bringing to the class-room the latest official statistics upon several subjects in different lines, requiring at the same time a reference to the page and volume which furnished them. This will not only bring the student into touch with reports and volumes, the existence of which is too often unknown, but will accustom him to use figures only when indorsed by a reliable reference.

If it has nothing else to recommend it, the scientific study of statistics should train the critical faculties of the student as well as any subject in the curriculum. There are altogether too many pleaders at present among us who are trying to make the worse appear the better reason, and are resting their argument upon the use or misuse of statistics. There are some writers who make mistakes because they lack proper training. A good course in statistics would preserve such from their errors. There are, unfortunately, others who distort their figures with the intention to deceive. Training in statistics would not save them. Their need is ethical. But a little better appreciation of the value and use of statistics is required by those who are sought as disciples by these perverters. Therefore, instructor and student alike should be continually on the watch for examples of statistical fallacy, and all should be brought to the attention of the class. Unfortunately, they are all too numerous, and often found in high places. The ability to detect a lurking

fallacy and prick the bubble of conceit which accompanies it is perhaps the hardest to develop in the student. And, above all else, each member of the course should be taught to direct to his own work the same searching criticism which he would give to that of another. To train this critical faculty is difficult, for the student has for years looked upon his text-books as the end of wisdom, but at the outset of his active life it is well for him to realize that the world moves, and that what seems true to-day may be proved false to-morrow. This mental attitude may be unsettling, but it is necessary for successful scientific work in any field.

As the extent and variety of the topics which lend themselves to statistical research dawn upon the student, he is likely to overestimate its services, and conclude that statistics can lay a finger upon every sore spot in the social body and point the way for its remedy. It is, therefore, desirable that the limitations of this method of study should be frankly admitted. It is, doubtless, advisable that charitable societies should keep records of the cases which are brought to their attention, that the causes of the unfortunate condition should be tabulated and the results published, that knowledge of the causes may possibly lead to remedial measures. But it is well-nigh impossible to determine with accuracy the primary and contributory causes of poverty. Especially is this the case with those which are caused by the weaknesses of human nature. Statistics of property and income may be gathered with all possible care, but, where there is a financial advantage to be gained by handing in false returns, the accuracy of such tables is problematical. No mistake is made by frankly pointing out the liability to error in such computations.

During the second half-year each student should be engaged upon the preparation of a statistical essay. There is no lack of material for such studies, but the greatest danger is that the student will endeavor to cover too much ground in his paper. He should be shown the advantage of a thorough and intensive treatment of a limited portion of a field rather than a superficial treatment of the whole of it. The material for countless valu-

able studies may be found in our census volumes, the reports of the various departments of the national government, and the vital statistics of certain selected States. In order to stimulate the interest of the men, I have often made use of the class books which are brought out by the secretaries of the different classes of Yale graduates. These appear at irregular intervals, but usually once in five years, following the class reunions. They are a vast storehouse of material for occupational and vital statistical studies. The men are almost always enthusiastic about a subject which deals with their college, and, when a paper of this kind is to be read before the class, the report spreads among the students outside the course, with the result that there are often a number of visitors to hear it. The college publications are always anxious to print papers of this nature. Students should report to the instructor from time to time during the preparation of the paper, to avoid any serious mistakes or omissions, and guard against the ever-present undergraduate temptation of procrastination, and the attempt to crowd into a week the work which should have covered three months. When the paper has been written, the student should be required to draw a chart which will visualize the most important results of the study. To encourage good drawing, I have for the past few years framed and hung in the class-room the most meritorious specimens. This has served as a great stimulus, and the result has been that some remarkably good specimens of work were handed in. The attempt was made to file these charts away, but, when the student had drawn one of which he was particularly proud, he usually wished to send it home. To obviate this difficulty, lantern slides are made of the charts. When the papers are read, these slides are thrown on the screen. There is in this a twofold advantage. The charts all appear of uniform size and large enough to be visible from all parts of the room, and the slides are more easily preserved than would be the originals. After the papers have been read, they are criticised by the class. Near the end of the year a mistake must be very subtle to escape detection. But the class benefits by this criticism, and the later papers

are usually a great advance over the earlier ones. Of course, some of the papers are prepared in a half-hearted and slovenly manner, but most of them are well above the average of undergraduate effort, and some of them have been printed in an economic journal. Work of this grade cannot be obtained from undergraduates by the task system. Knowledge for its own sake may be desirable, but, to persuade a student to do his best, some form of rivalry is necessary. The fear of failure to pass the course may produce a certain standard of work, but this is always low, and the stimulus fails at the point where reasonably good work commences. Unless a higher working motive can be discovered, the spirit of emulation must be encouraged.

When a student has completed a course of this nature, he has gained some idea of the measurement of the social forces, he knows the intensity of various economic and social phenomena in different countries, and he is prepared to get the meaning from columns of correlated figures. He can read critically and detect a fallacy that is not too well masked. But, above all, he has gained power. He realizes that he has done a piece of first-hand statistical work. He may still be somewhat clumsy in the use of his tools, but he knows what they are for, and with sufficient practice he may yet become a finished workman.